apparent velocity differs from the true velocity also because the earth is itself in motion. When these two causes are taken into consideration the true radiant is found to be the point whose celestial longitude and latitude are, respectively,

106° 2′
+3° 42′

and the true velocity is 31 miles per second.

As will be noticed, the velocity is about 20 per cent in excess of that to be ascribed to parabolic motion, and places the meteor in the hyperbolic class. I am perfectly aware that the burden of proof rests upon the person that assumes hyperbolic velocity for cosmic bodies, but as the assumption of a parabola would prolong the time of visible flight by two seconds, I have preferred to retain the velocity as above given. Computing the elements by the known formulas of theoretical astronomy we have

Longitude of ascending node	351° 31′
Inclination to ecliptic	4° 0′
Longitude of perihelion	209° 1′
Logarithm of perihelion distance	9.9434
Eccentricity	1.696

If one is disposed to reject the hyperbolic velocity from general principles, the orbit is not varied more than might easily arise from the uncertainty of the observations, and there results

Longitude of node	351° 31′
Inclination to ecliptic	2° 58′
Longitude of perihelion	206° 21′
Logarithm of perihelion distance	9.9597

COOLING BY EXPANSION AND WARMING BY COMPRESSION.

By CHARLES EMERSON PEET. Dated Lewis Institute, Chicago, Ill.
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The following method of cooling by expansion and condensation of the water vapor of the air into a visible cloud of water particles may be of interest to instructors in physiography. It is a method which I have used with success for several years. The apparatus necessary is: (1) an air pump. (2) a bell jar. (3) a bottle with a snug fitting cork, coated with vaseline. The bottle is corked and placed under the bell jar and the air is exhausted from the bell jar. The cork is pushed out of the bottle by the air inside. The sudden expansion causes cooling enough to condense the water vapor into a cloud which remains visible for a considerable time. Slow leakage of the air into the bell jar may produce warming by compression enough to reevaporate the water. This warming by compression is made more striking if the bell jar is provided with a stop-cock by which the air may be admitted more rapidly and in a manner which is apparent to the class. The success of the experiment varies with the humidity of the air, but under the most unfavorable circumstances it is never an entire failure. The size of the bottle to be used and the force with which the cork should be forced into it can easily be determined by trial. The cloud in the bottle may be made more clearly visible by providing it with a proper background.

ESPY'S NEPHELOSCOPE.

The experiment above described by Professor Peet implies the use of an air pump, whereas the following method, which has often been used by the Editor, not only requires no expensive apparatus, but has several other advantages. A bottle (A) properly corked, has inside of it an ordinary elastic-rubber toy balloon (B), which, when but slightly distended, occupies only two or three cubic inches. A glass (or preferably a rubber) tube enters the mouth of the balloon, and also passes outward air-tight, thru the cork. On blowing thru the tube, or forcing air by any other method into the balloon, the latter is distended, and of course the air within the bottle is comprest. Wait until this comprest air has lost its warmth, which it quickly does by conduction and radiation to the sides of the bottle, then remove the finger from the rubber tube and allow the comprest air of the bottle to push the air within the balloon outward thru the rubber tube. The work done by this expansion cools it enough to produce the most delicate cloud of condensed vapor, which is visible until the radiation of heat from the sides of the bottle evaporates the globules of water. The experiment may be repeated over and over with the same air always in the bottle; and if a thermometer be added, together with some way of measuring the volume of comprest air, then really instructive computations may be made. If a little water be kept in the bottle, but outside the balloon, we may arrange so to deal always with saturated air, and the haze will be more easily visible to a large class. If no water be present then we have to deal with unsaturated air, and may make a large variety of experiments.

One of the first phenomena that the teacher and scholar will note is the fact that after a few trials it becomes more and more difficult to secure any visible haze. This is the phenomenon first recorded by Espy, and was a mystery to him and everyone else until Aitken showed that vapor condenses most easily on minute solid nuclei, and by its weight carries them to the bottom or sides of the jar, where they stick fast, so that after a few trials no more nuclei remain. Then comes the phenomenon first studied by C. T. R. Wilson, of Cambridge, England, who showed that in dustless air a greater expansion and therefore a greater cooling is necessary in order to produce visible globules. This may lead us on to the consideration of ions, if the scholar is far enough advanced for the subject. At least it is proper to call his attention to the fact that the interior of a cloud is dustless, and that here greater expansion seems to be necessary, and consequently greater cooling, and that therefore a greater liberation of latent heat occurs within the interior of a thundercloud than in that same air when it first rises high enough to become cloudy.

Instead of water one may introduce other liquids into the experimental bottle, which is in fact a modification of Espy's single nepheloscope, and may thus experiment upon carbonic acid gas, the vapors of alcohol, ammonia, etc.

The double nepheloscope devised by Espy may be imitated by connecting two clear glass bottles (C) and (D) by means of two rubber tubes to a central bottle or receiver (E), from which the air can be exhausted. By a spring clip close one tube so that the air may be exhausted from the receiver (E) and one bottle (C), while not exhausted from the other bottle (D). Then remove the clip from (D) and allow its air to pass over into (E) and (C). The student will be surprised to find that no cloud is formed. This experiment troubled Professor Espy very much about 1850, as he had up to that time been reasoning on the general principle that the atmosphere is cooled by the act of expansion, but here he evidently had expansion without cooling. It was Prof. William Thomson, of the University of Glasgow, now Lord Kelvin, who, by his work on thermodynamics, first gave the true explanation, namely, that it is not the mere expansion that produces cooling but the work done by expansion. When the air expands from (D) into the vacuum (E) and (C) there is no work done except the moving of about one-half the mass of air in (D) over into the empty jars (E) and (C), and the cooling is too slight to produce a visible haze; it was, in fact, too slight for Espy to measure with his most delicate thermometer. On the other hand, when the comprest air in the bottle (A) pushes the air in the balloon (B) out into the open air it is doing heavy work by pushing against the outside atmospheric pressure, just as does the steam in the cylinder and boiler of an engine.—*C. A.*